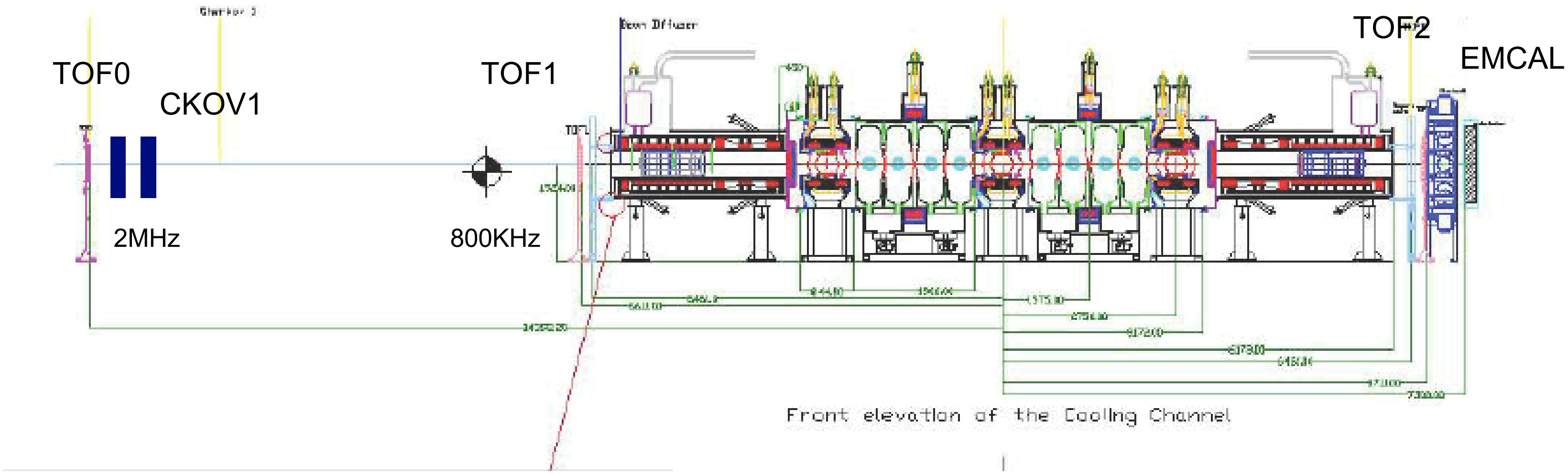
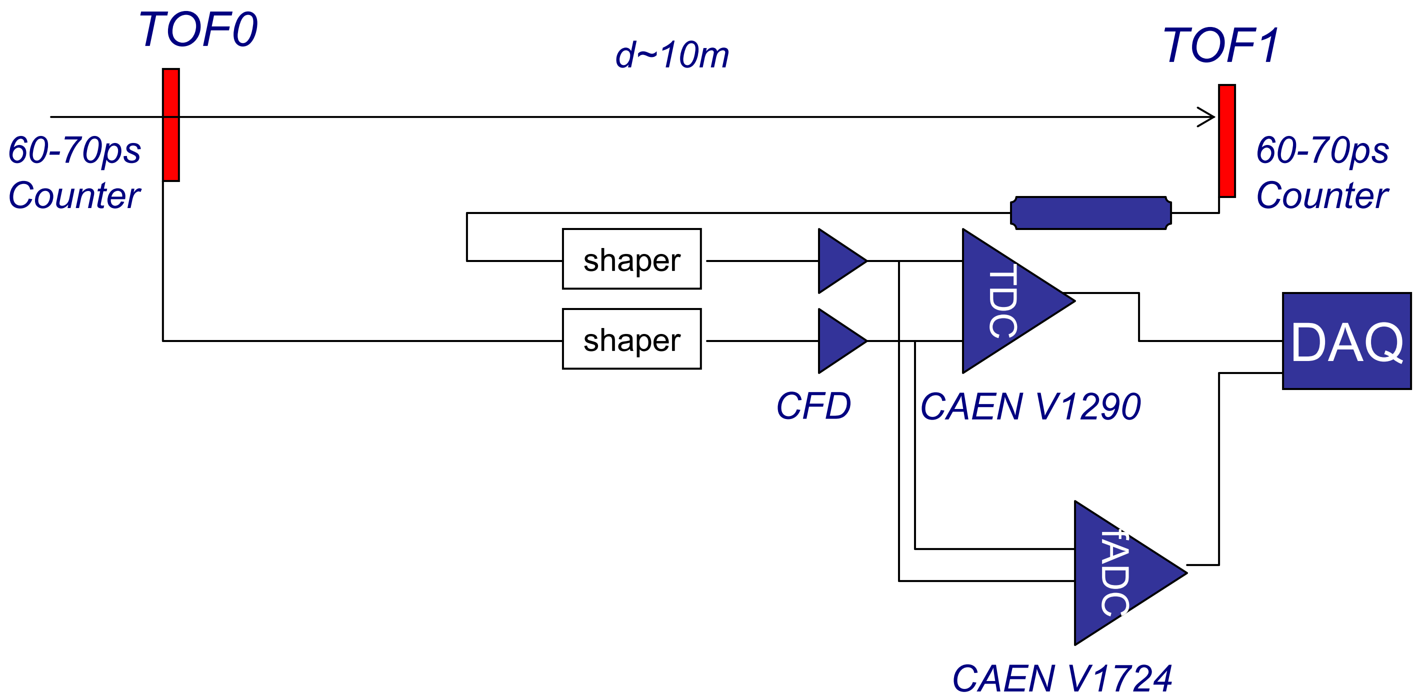
PID in the MICE Experiment

- To eliminate false emmitance signatures by pions and decay positrons in the MICE cooling channel.
- TOF0, TOF1, CKOV1 reject pions (~10^{-3}) in upMice.
- TOF1, TOF2, EMCAL reject muon (~10^{-3})decays in dwnMice.
- Painting with Broad Strokes.(Ghislain Gregoire, Don Summers, Maurizio Bonesini, Rickard Sandstrom, Ludvico Tortora, Vittorio Palladino PID Coord.)



TOF SYSTEM in MICE

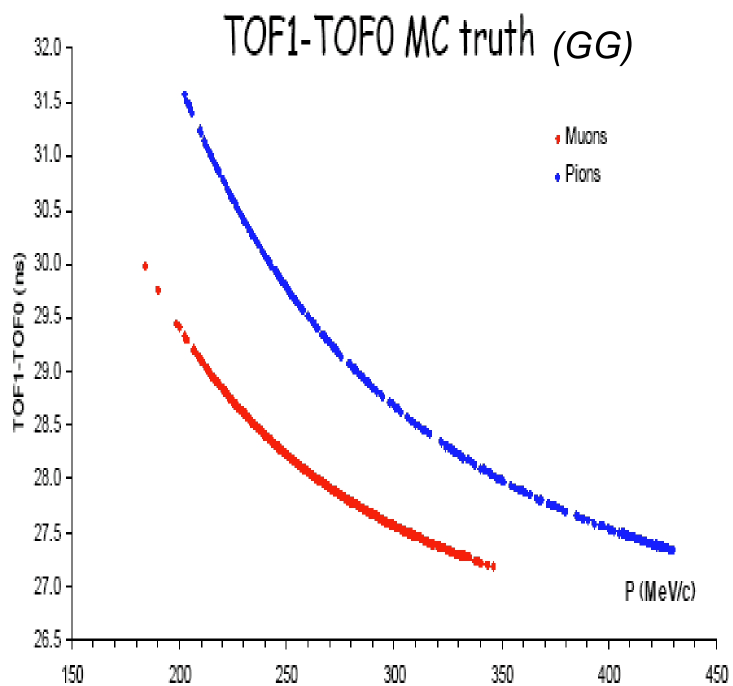
$$t = \frac{d}{c}\sqrt{1 + \left(\frac{m}{p}\right)^2}$$



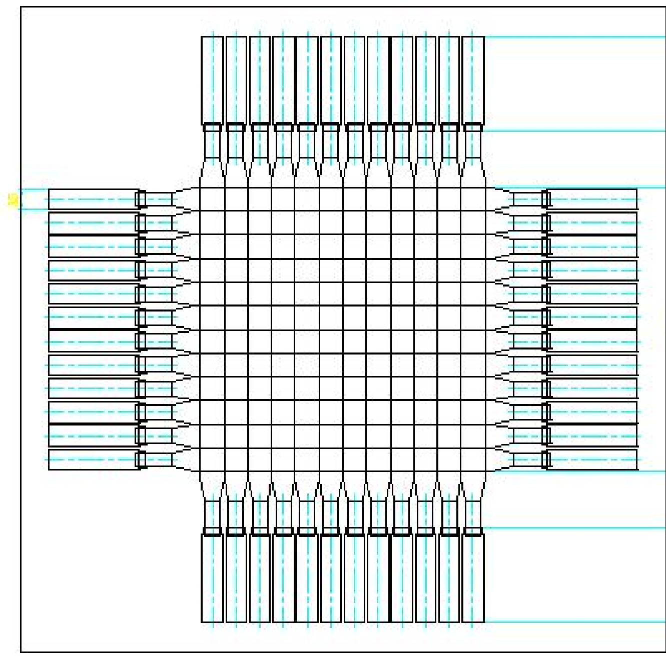
TOF Resolution(1)

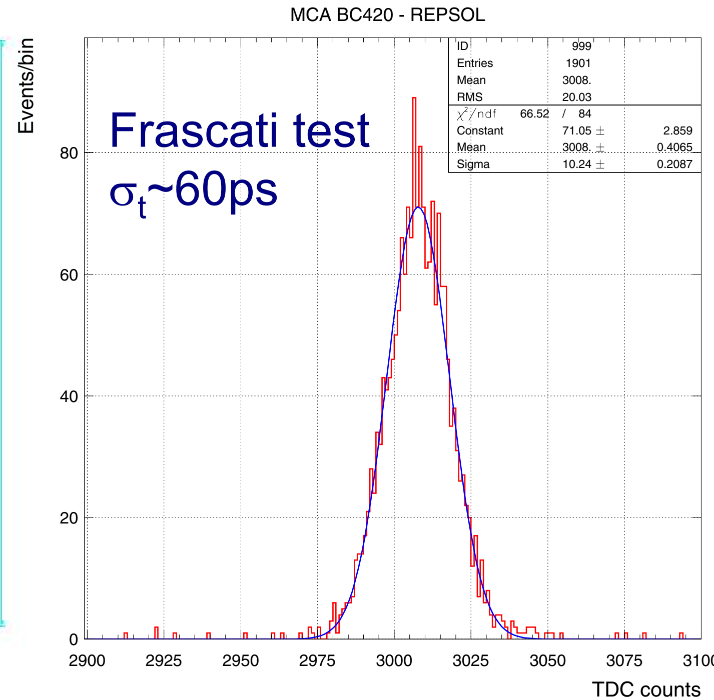
$$\sigma_{TOF} = \sqrt{\underbrace{\sigma^2_{\text{int}\,rinsic}}_{\substack{Sc\,\text{int}\,illator\\+PMT}} + \underbrace{\sigma^2_{t0} + \sigma^2_{Z-position} + \sigma^2_{electronics}}_{\substack{Calibration\\System}} + \underbrace{\sigma^2_{time-walk}}_{CFD+ADC} + \underbrace{\sigma^2_{momentum}}_{Trac\,\text{ker}}}$$

$$\sigma_{\text{int}\,rinsic} = \sqrt{\left(\frac{1}{2.35}\right)^2 \left\{ \tau^2_{scin} + \left[\frac{n(n-1)L}{2c}\right]^2 + \tau^2_{T-jitter} \right\}} \Big/ \sqrt{N_{pe}}$$



TOF Scintillator Arrays





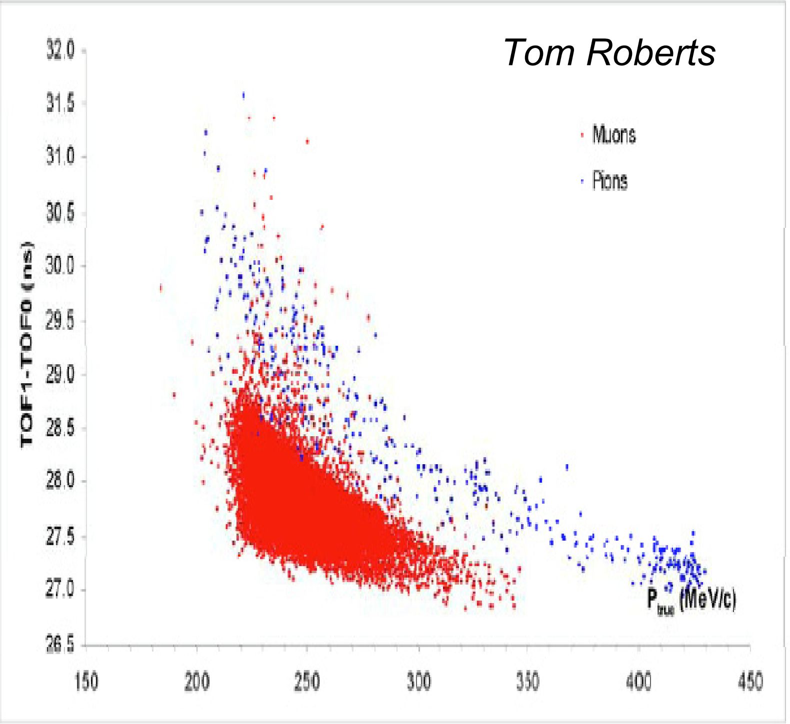
- Fast BC404/408 τ_D~1.5ns or similar Scintillator.
- Hamamatsu 4998 or similar PMTs with fast TTS(160ps), risetime τ~0.7ps
- X-Y array gives σ_τ/sqrt(2) at each TOF station.

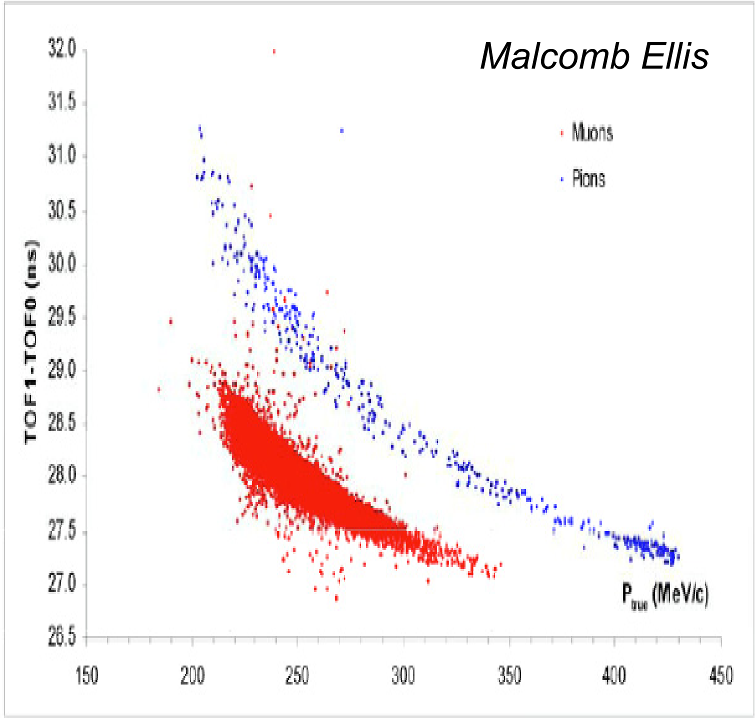
TOF0/1 Resolution (tracker+) (G.G.)

$$\sigma_{P_T} = 3\ MeV/c$$

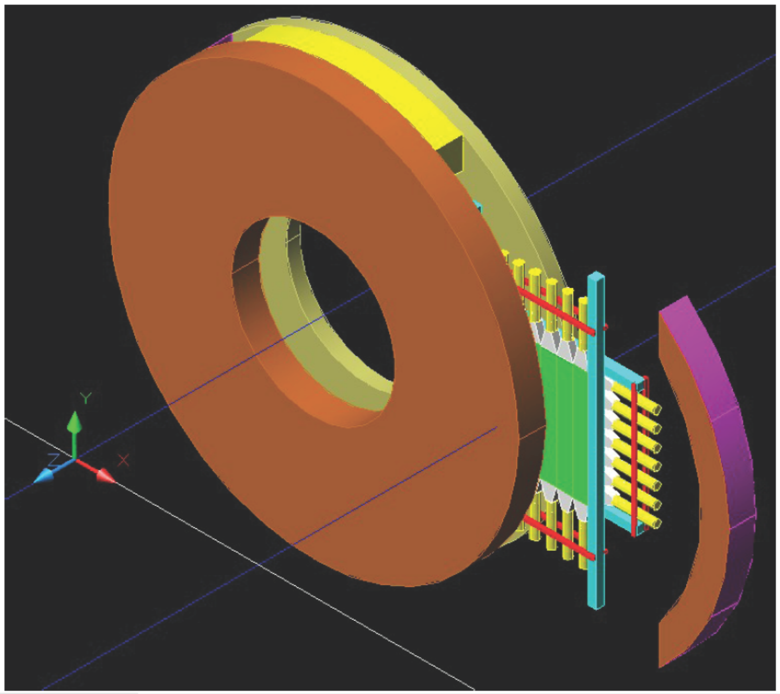
$$\sigma_{P_Z} = \frac{75}{3 + p_T}$$

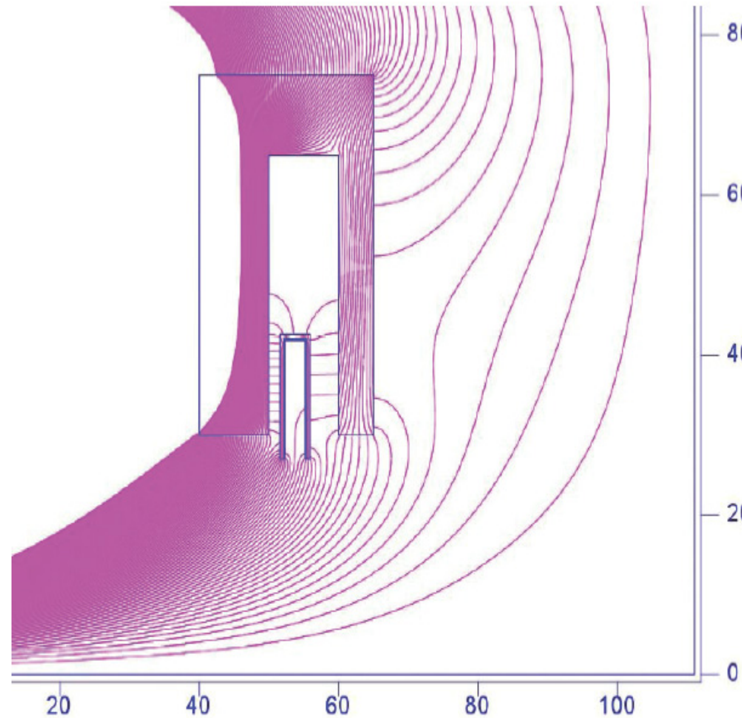
$$\sigma_{p_Z}^2 = \frac{k_1^2}{p_T^2} + k_2^2$$





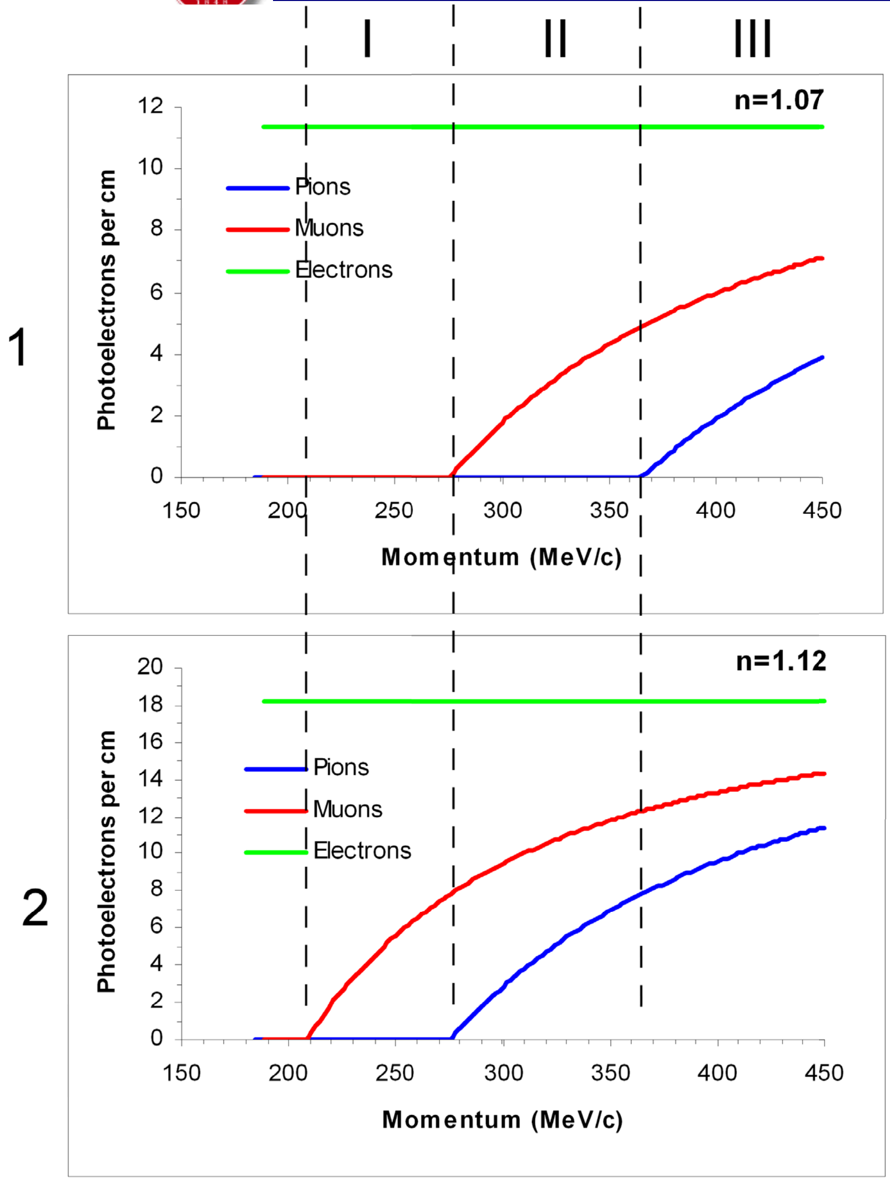
TOF1/2 Magnetic Shielding (G.G.)

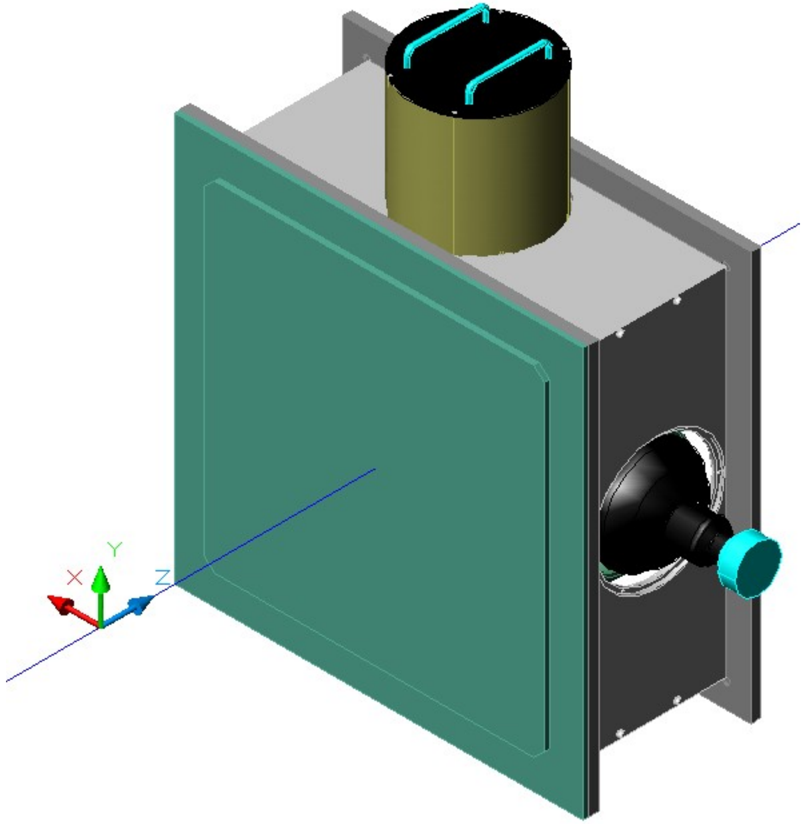




Fields are reduced to ~50 gauss near PMTs by a novel mirror plate design.

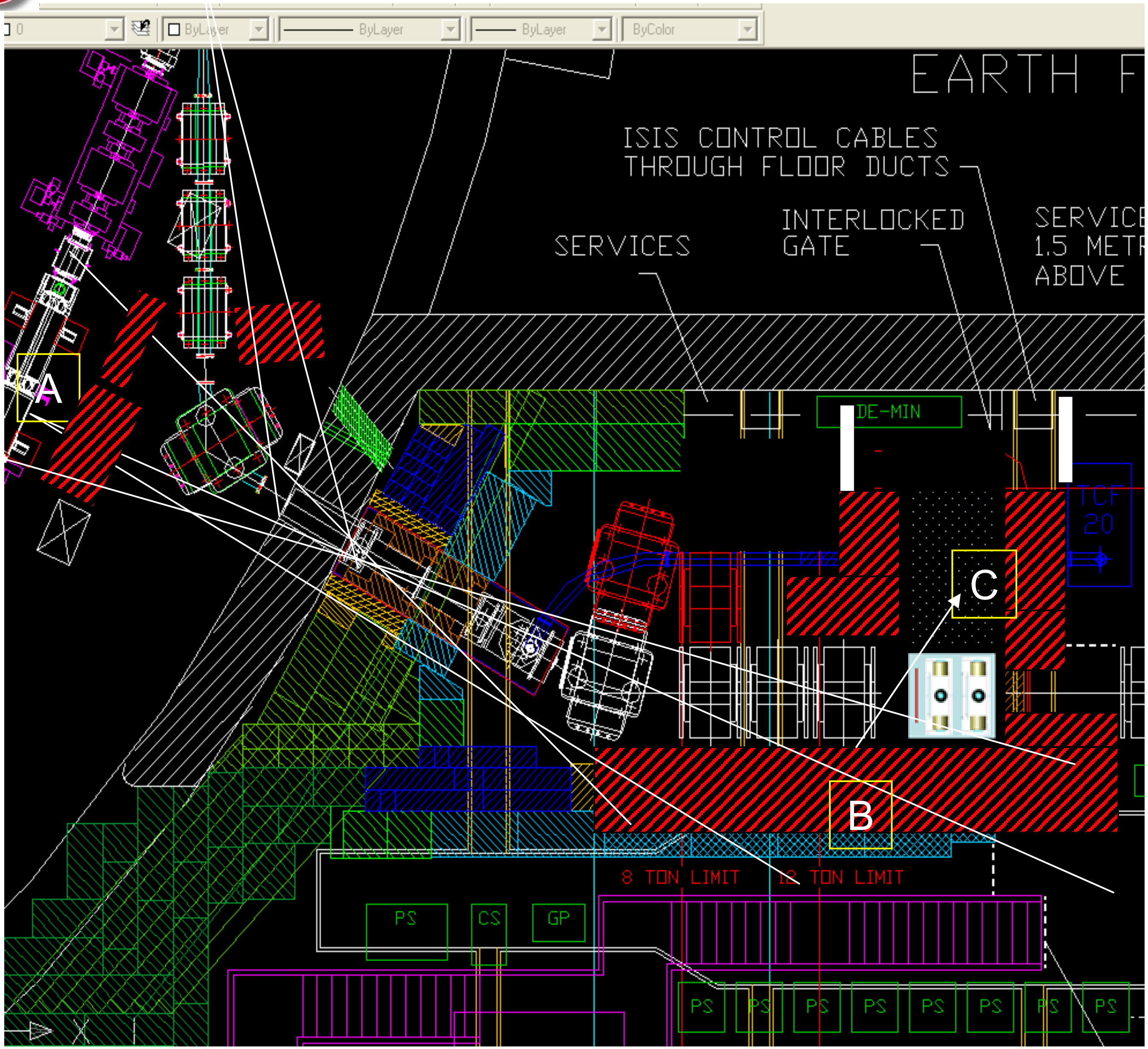
CKOV1 Threshold Aerogel Counters





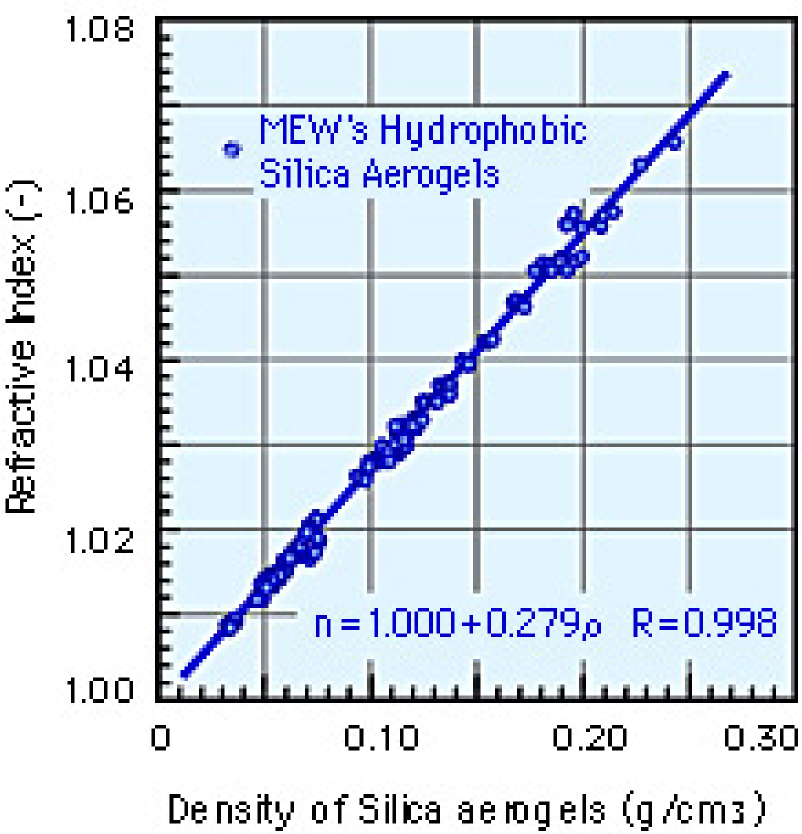
Aerogel Counter

ISIS Beam Line

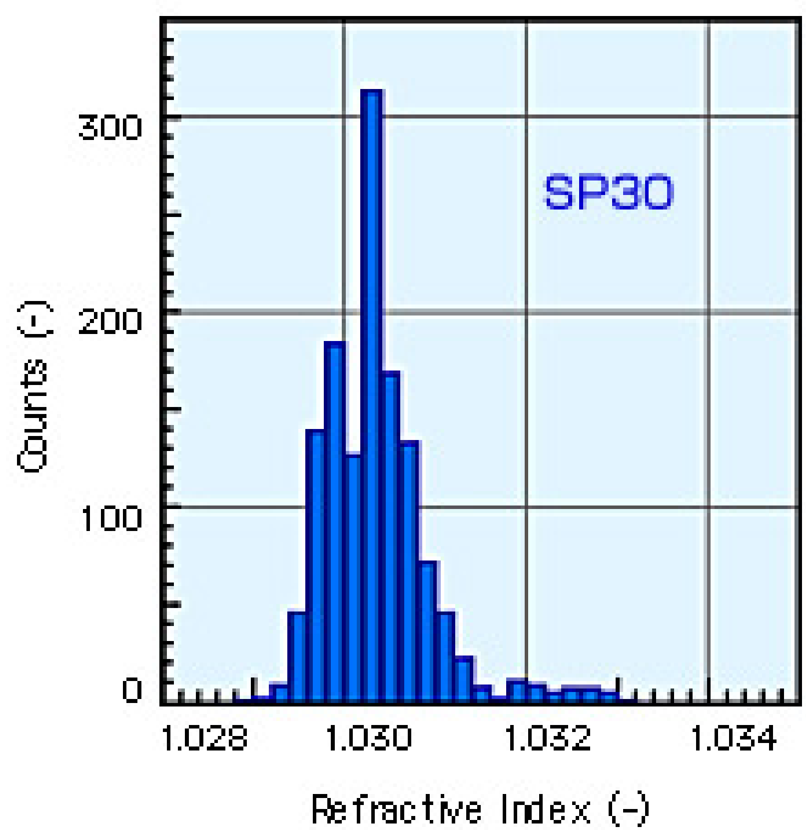


Matsushita Electric Works

Correlation between densities and refractive Indexes of MEW's hydrophobic silica aergels

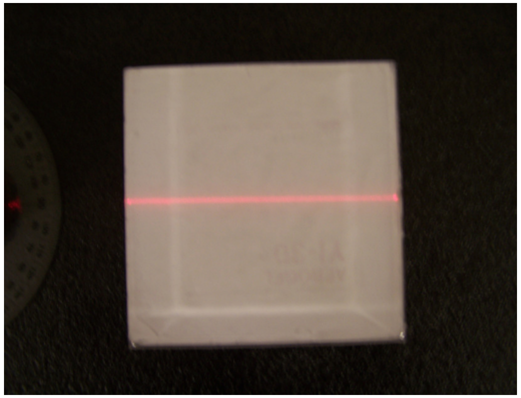
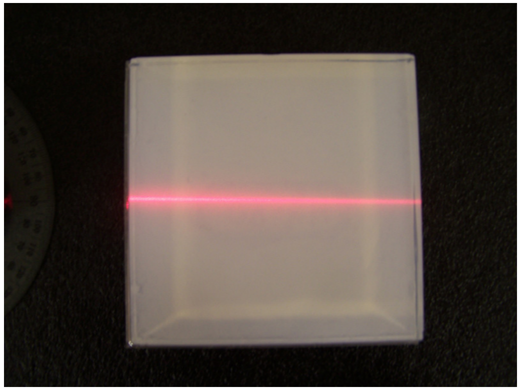
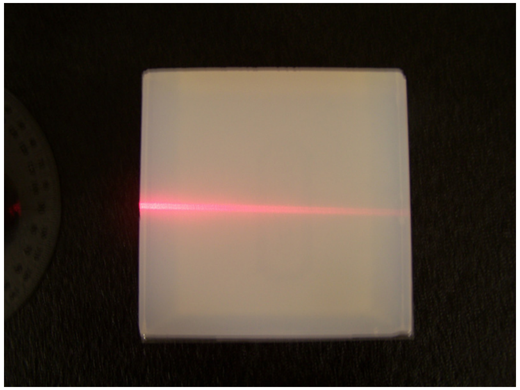


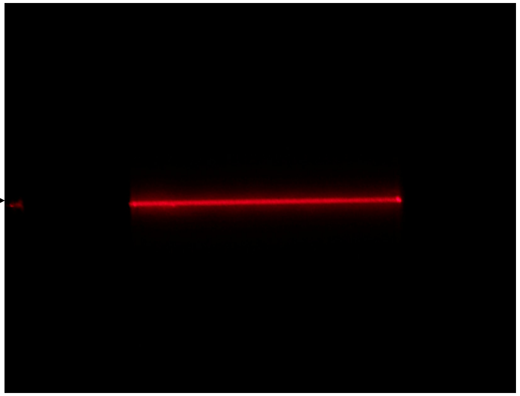
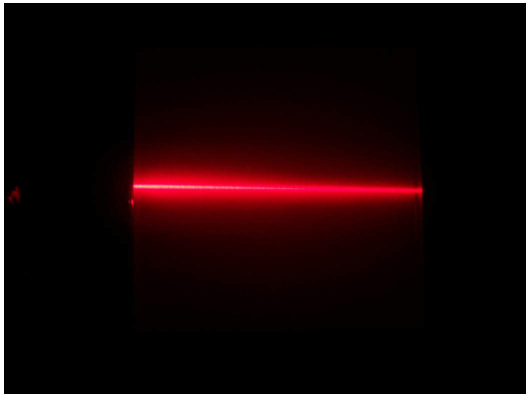
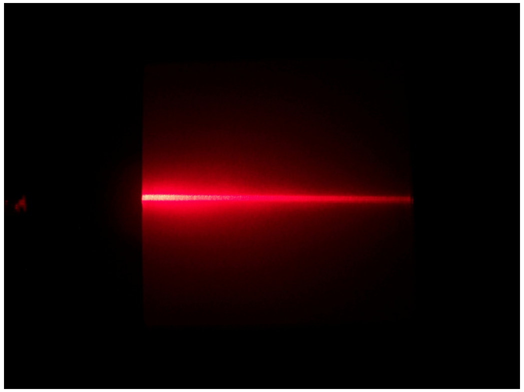
Refractive index distribution of the products(SP30, n=1.030)



Matsushita Aerogel Samples

n=1.03 | n=1.07(1.08) | n=1.12

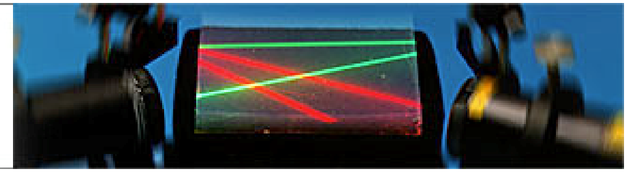
115 x 115 x 10.5 mm^3 | 115 x 115 x 11.5 mm^3 | 115 x 115 x 11.5 mm^3

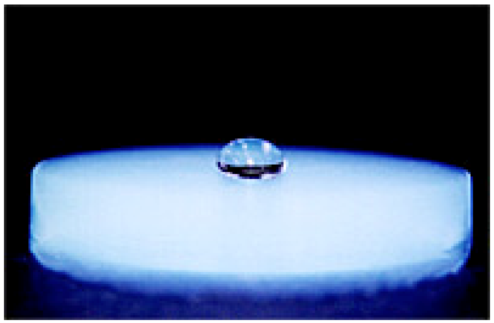
Matsushita Electric Works, Ltd.

Keywords

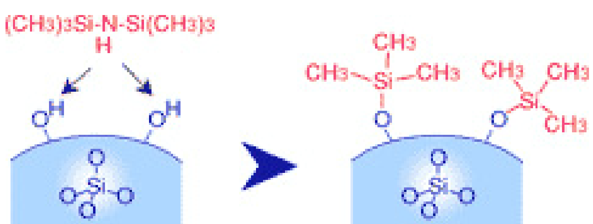
Hydrophobic Silica Aerogel

for Science





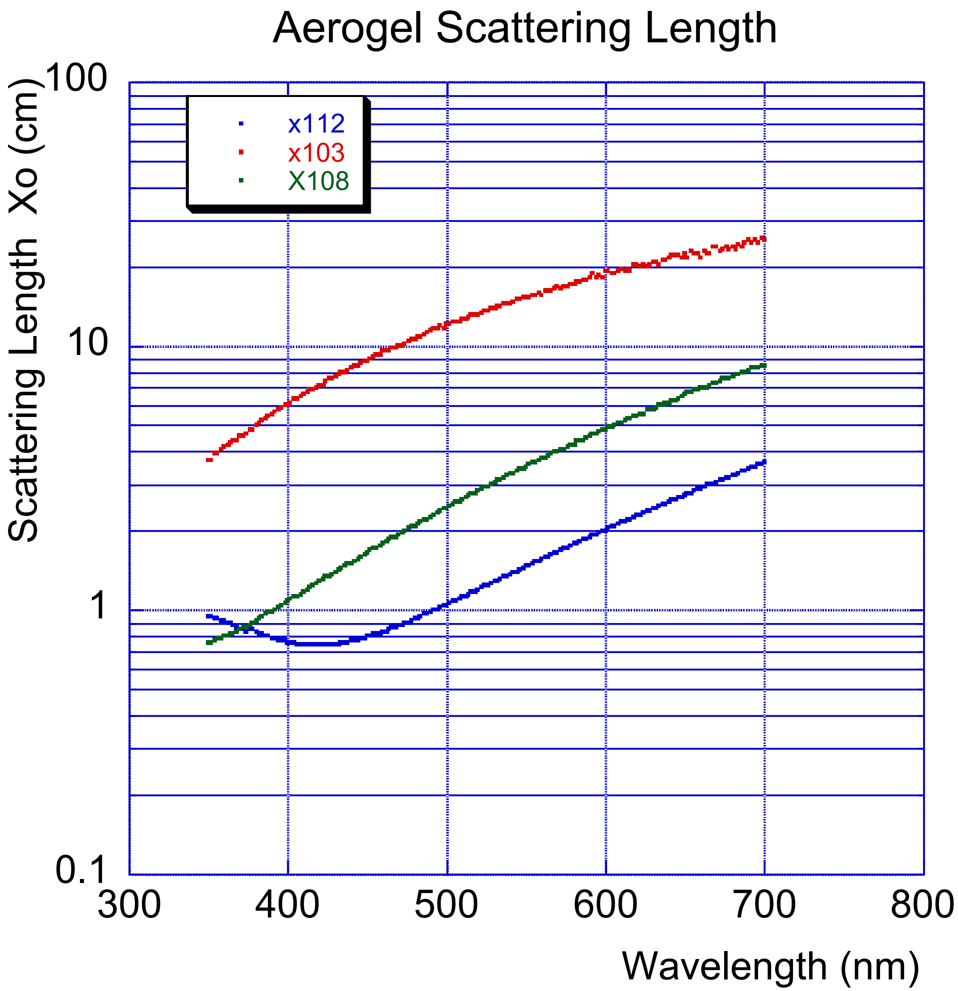
MEW's silica aerogel has high resistance for water and moisture due to it's hydrophobicity.
Their properties are stable in any climate.
This feature contributes the higher reliability
for your analysis.



TMS modification on SiO_2 micro particles surface in aerogel

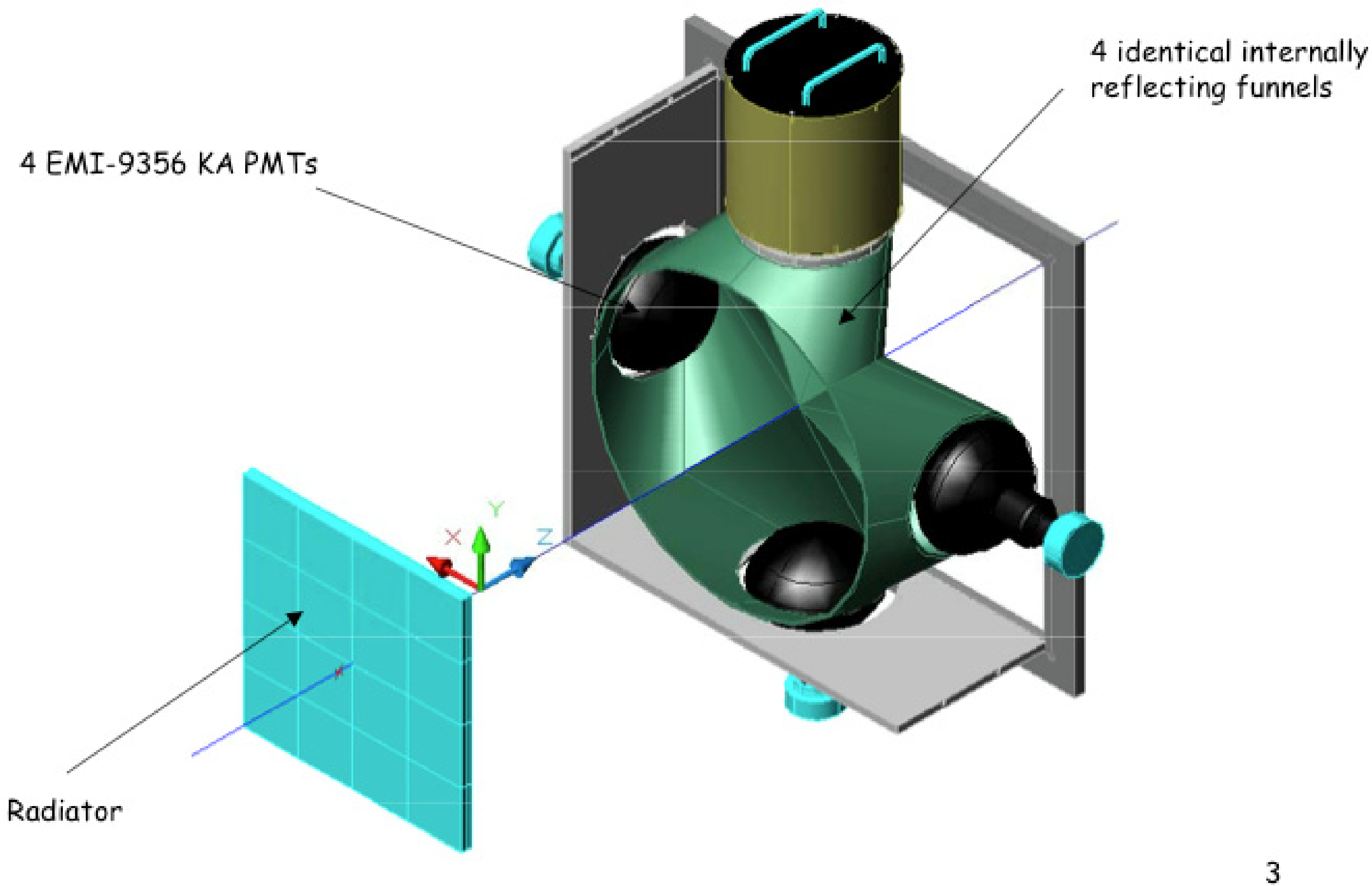
Not only the surface of tile, but also internal SiO_2 particles of tile are uniformly modified by trimethylsilil group(TMS).
Even if tiles are cracked or broken, proper tiles will not be degraded.

Aerogel Scattering Length



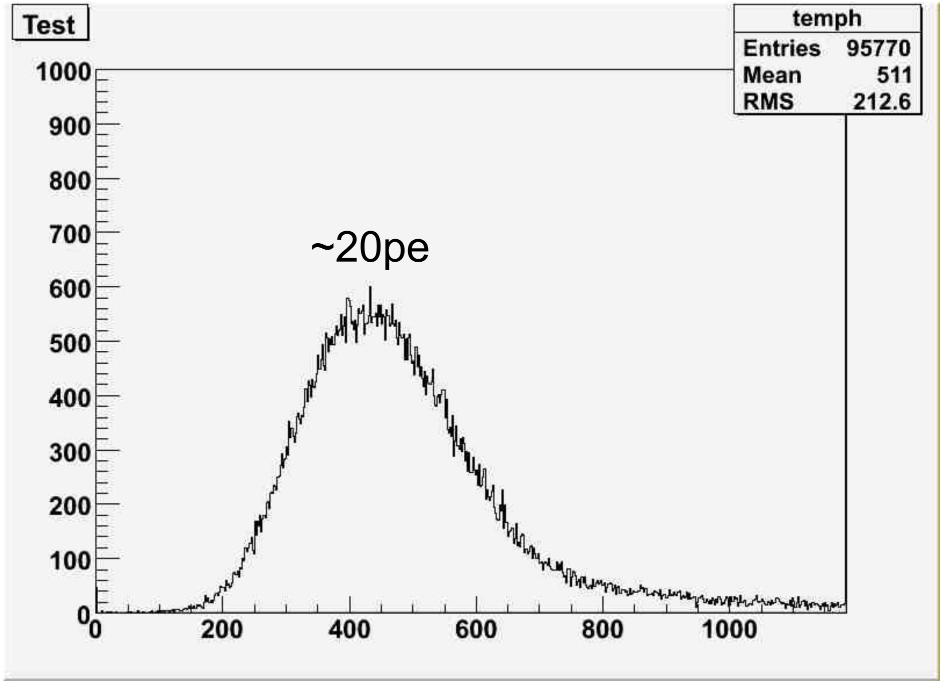
Aerogel Counter

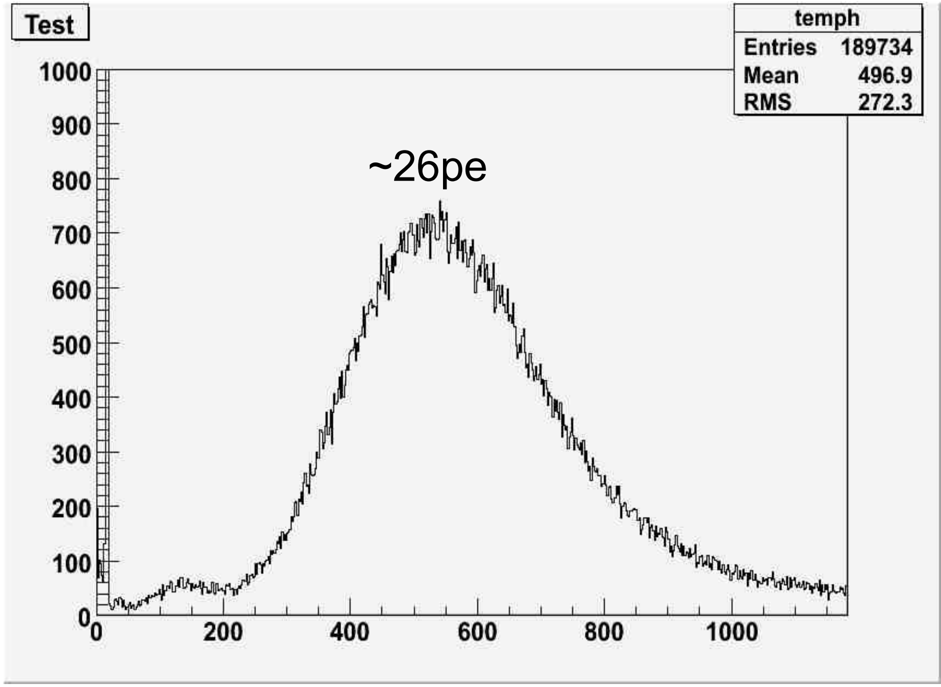
Detection unit



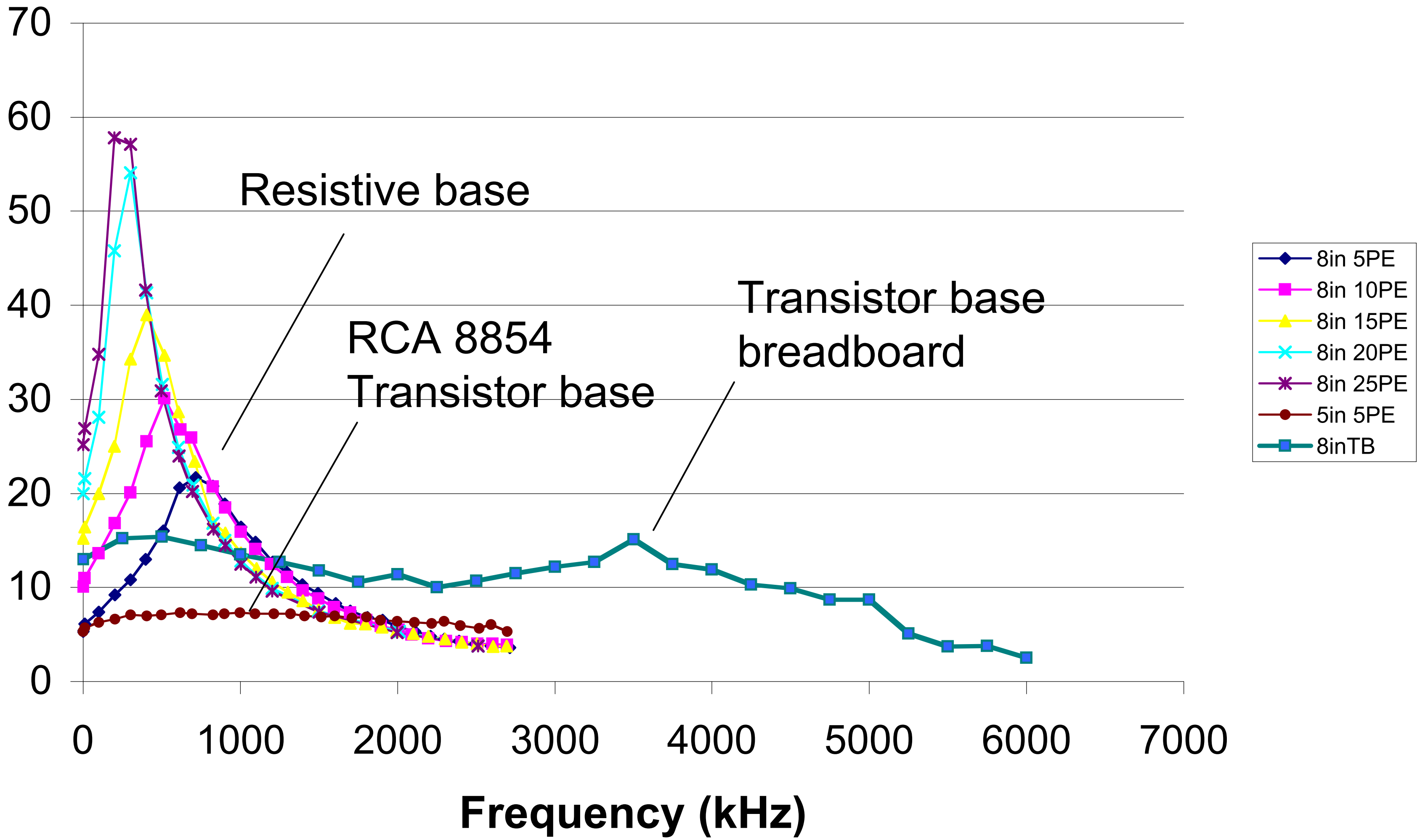
FNAL Beam Test

- Prototype Device tested in 120 GeV/c proton beam.
- Good photoelectrons yields at β=1 consistent with small aerogel absorption hypothesis.





Number of Photo Electrons vs Frequency



D. Bartlett et al. / Performance of Cherenkov counters

RCA 8854 5" Tube
+HV=3KV
NIM A69 (1987) 55-75

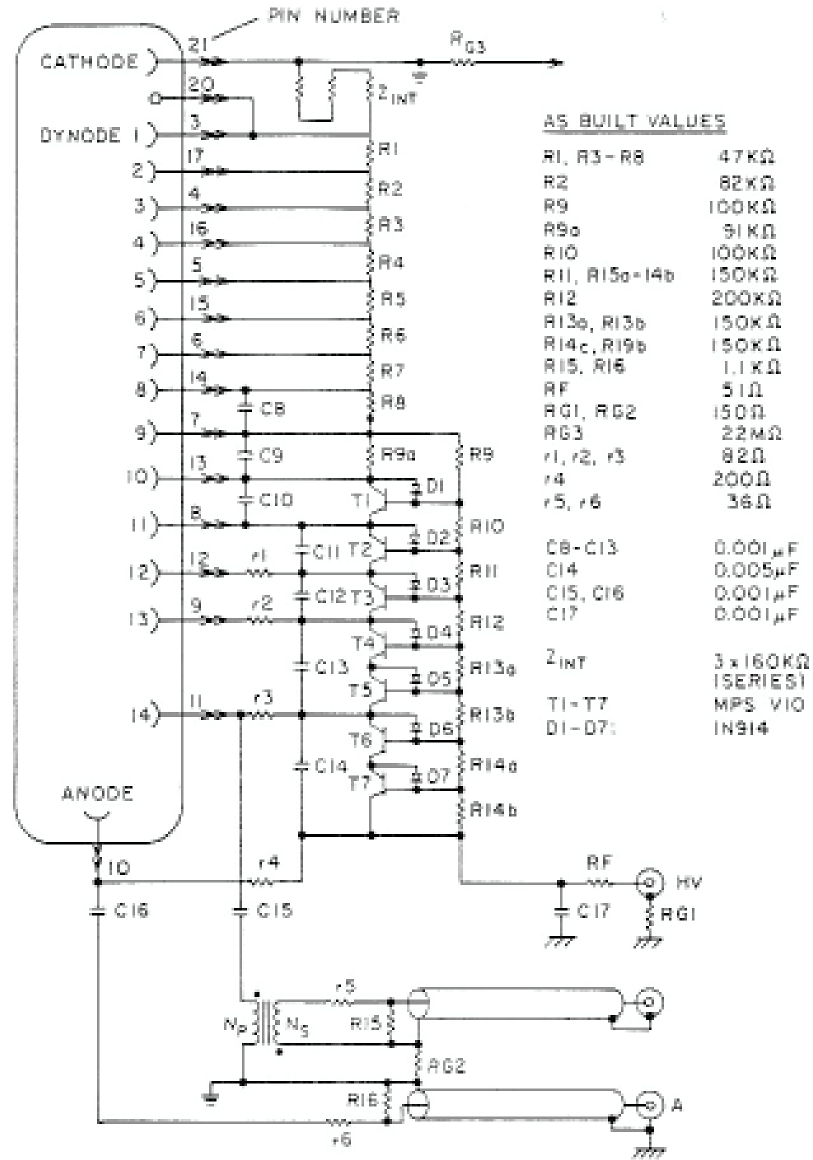
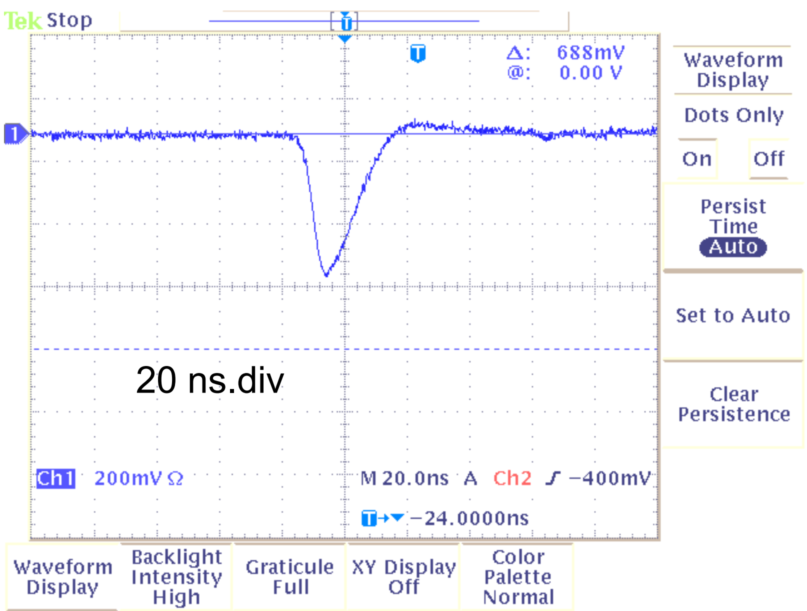
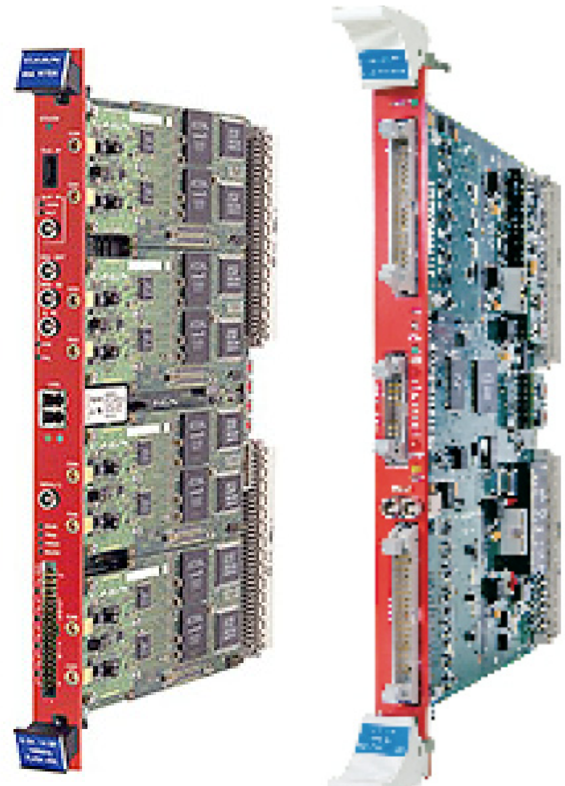


Fig. 12. Circuit diagram for the dynode voltage chain and signal output in the Cherenkov photomultiplier tubes.

TOF/CKOV1 Electronics

- CAEN V1724
  - 8 Channel 14 bit 100 MS/s FlashADC
  - 500 ps Δt resolution
- CAEN V1290 TDC
  - 25 ps Δt resolution





CKOV1 Purity

$$Purity = 1 - \frac{Nr.Pions}{Nr.Pions + Nr.Muons}$$

a) without electronic threshold

	107off/112off		107off/112on	107on/112on
	I off / II off	I on/II off	I off / II on	I on / II on
No momentum cut	87.819 %	0 %	99.983 %	99.683 %
With momentum cut $p_\mu < 365$ MeV/c	80.819 %	0 %	99.984 %	100 %

b) with an electronic threshold of 1 photoelectron

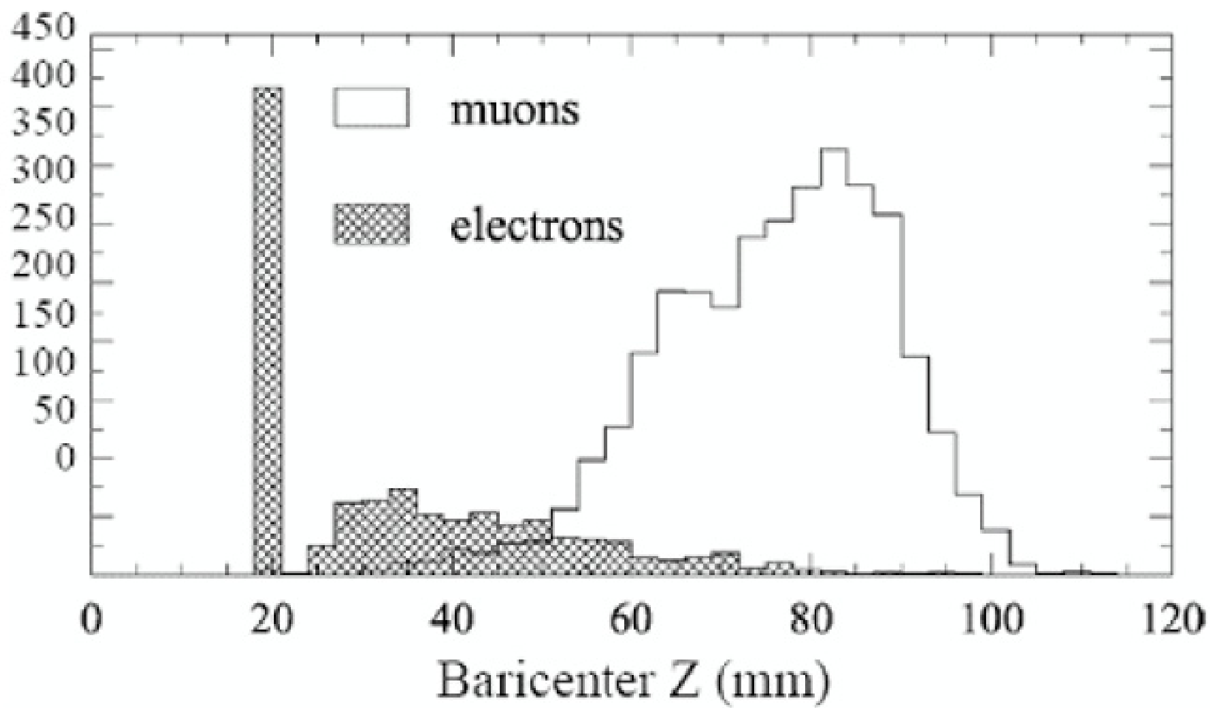
	I off / II off	I on/II off	I off / II on	I on / II on
No momentum cut	98.607 %	0 %	99.983 %	99.351 %
With momentum cut $p_\mu < 365$ MeV/c	98.607 %		99.988 %	100 %

Table 8.3.3. Purity matrix of the trigger configurations for good muons.

- *Purity = Percent of good muons for a particular Trigger Configuration.*
- *Muon Purity >99%* *Pion Misid < 1.2 x 10-4*

EMCAL

- Positron/muon range calorimeter at Tracker Solenoid exit.
- Grooved Pb Plates+scintillating fiber (KLOE design).
- 2 detector designs being studied.
- KL-(4)PbSciF or SW-(1)PbSciF+(3)Sci
- Analysis Method wTOF1/2+EMCAL being developed.



TOF/EMCAL Performance Stage6

Same thing again, expressed in *impurity*

Initial mom.	No cal., with TOF	KL, no TOF	SW, no TOF	KL, with TOF	SW, with TOF
140±14 MeV/c	0.24%	0.20%	0.093%	0.19%	0.093%
170±17 MeV/c	0.17%	0.19%	0.17%	0.16%	0.12%
200±20 MeV/c	0.14%	0.15%	0.091%	0.073%	0.044%
240±24 MeV/c	0.089%	0.088%	0.022%	0.050%	0.020%
TURTLE				0.070%	

Not meeting req. Meeting basic req. Meeting safety req.

Rikard Sandstrom-Geneva

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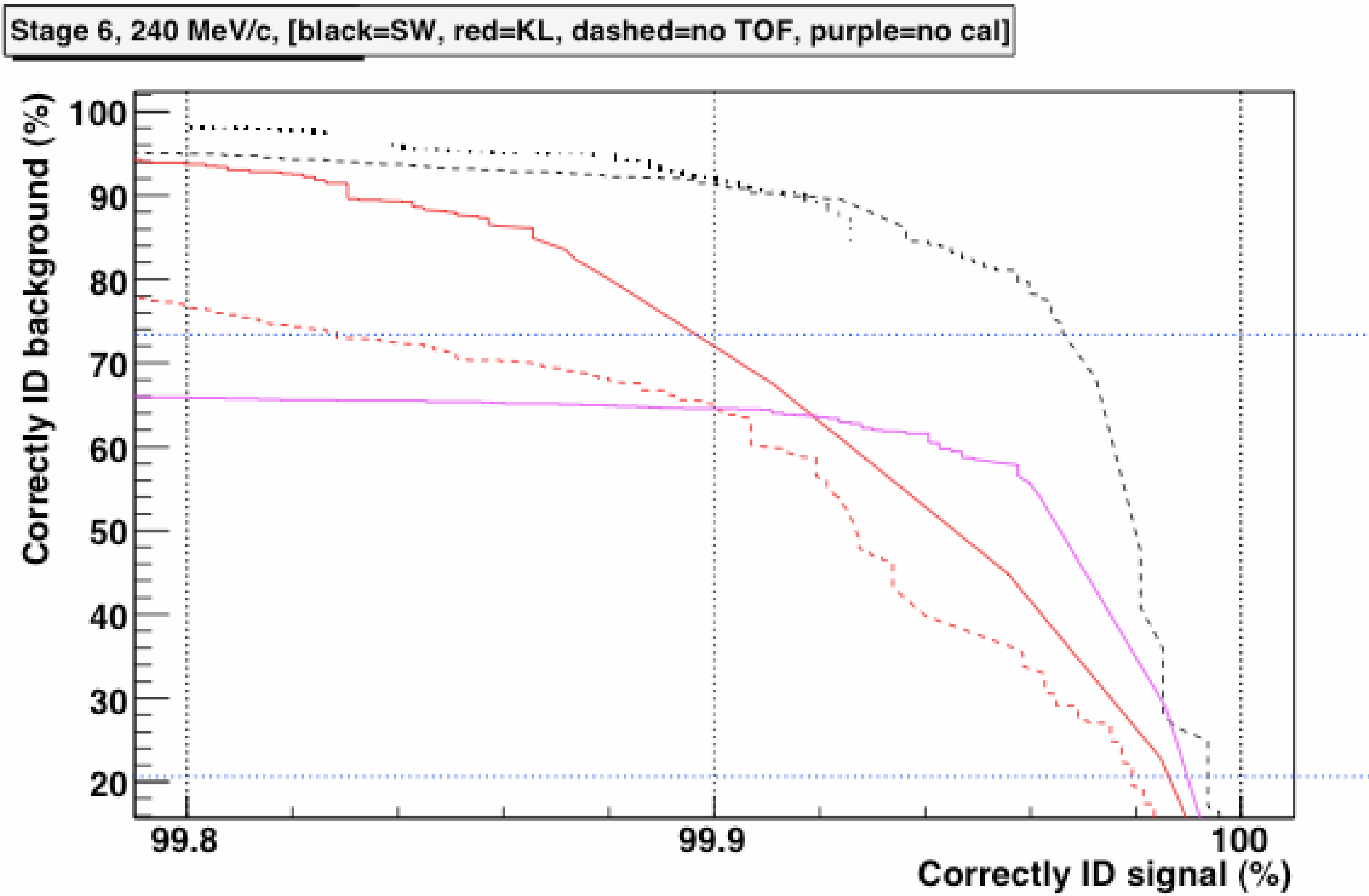

Figure 19: The PID performance in stage 6, $p_z^{OF1} = 240 \pm 24$ MeV/c. The blue lines correspond to 99. % and 99.933% purity respectively.

Summary

- Design of sub-100ps TOF system solid and tested. TOF1/2 Magnetic shielding tough, but solution in hand.
- Aerogel Cerenkov complimentary pμ>230MeV/c & important at MICE at startup.
- TOF12/EMCAL dwnMICE system well developed and capable of providing μ->e$\nu\nu$ rejection.
- Some PID funding issues-contribtions welcome.